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(71) Applicant(s)
NCR International Inc

(Incorporated in USA - Delaware)

1700 South Patterson Boulevard, Dayton, Ohio 45479, United States of America

(72) Inventor(s)
Angela Margaret Champness
Leo Monteban

(74) Agent and/or Address for Service
R G Robinson
International Patent Department, NCR Limited, 915 High Road, North Finchley, LONDON, N12 8QJ, United Kingdom

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ONLINE DATABASES: WPI

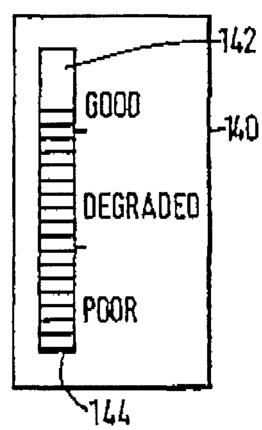
(54) Mobile wireless station having communications quality indicator

(57) A wireless communications system includes a backbone LAN having a plurality of access points which communicate with mobile stations (20). Each mobile station (20) monitors the communications quality (42) of received beacon messages transmitted at regular intervals by the access point (16) with which the mobile station (20) is signed on, and provides a visual indication (142) of communication quality.

In assessing communications quality, the mobile station (20) may monitor the noise level, the strength of the received beacon messages and the noise level at the access point (transmitted as part of the beacon message).

If the communications quality falls below a particular threshold, the mobile may search for a new access point.

FIG.7A



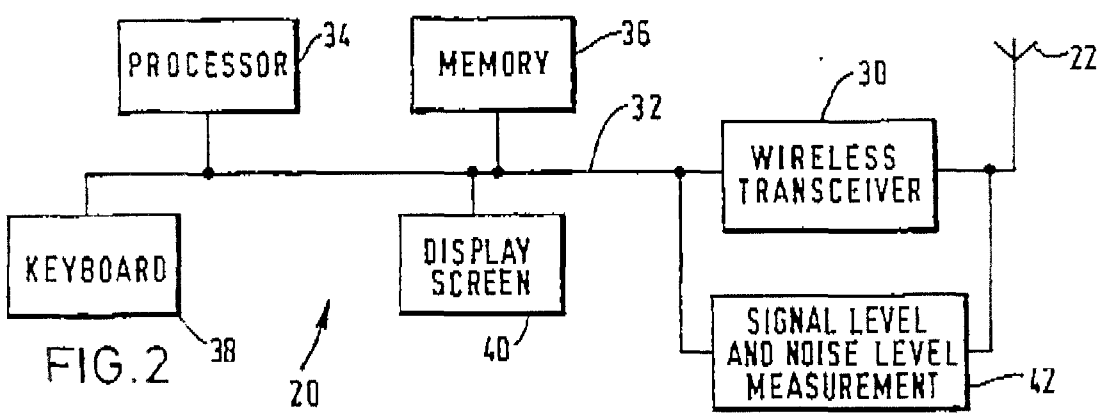


FIG.2

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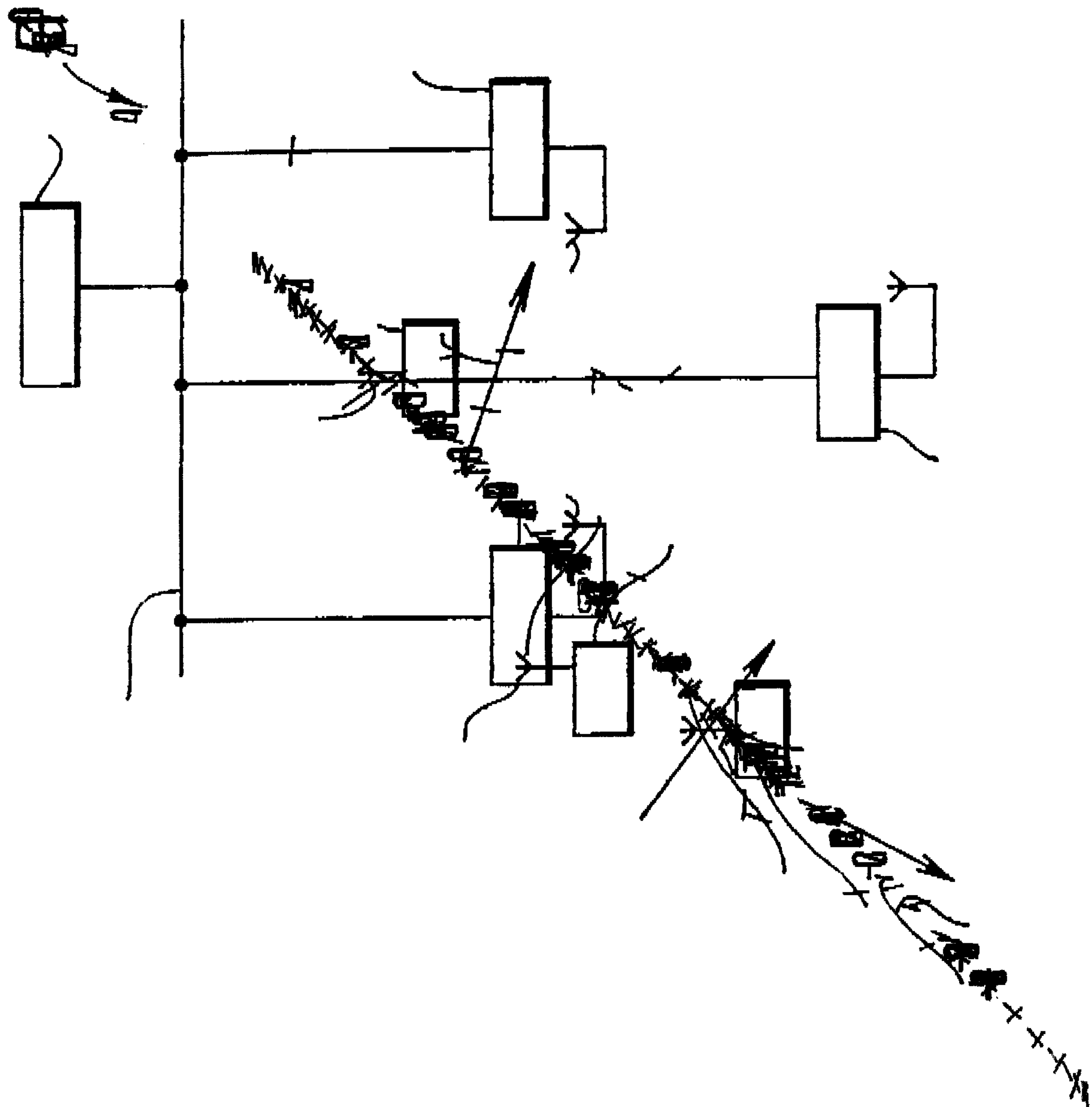
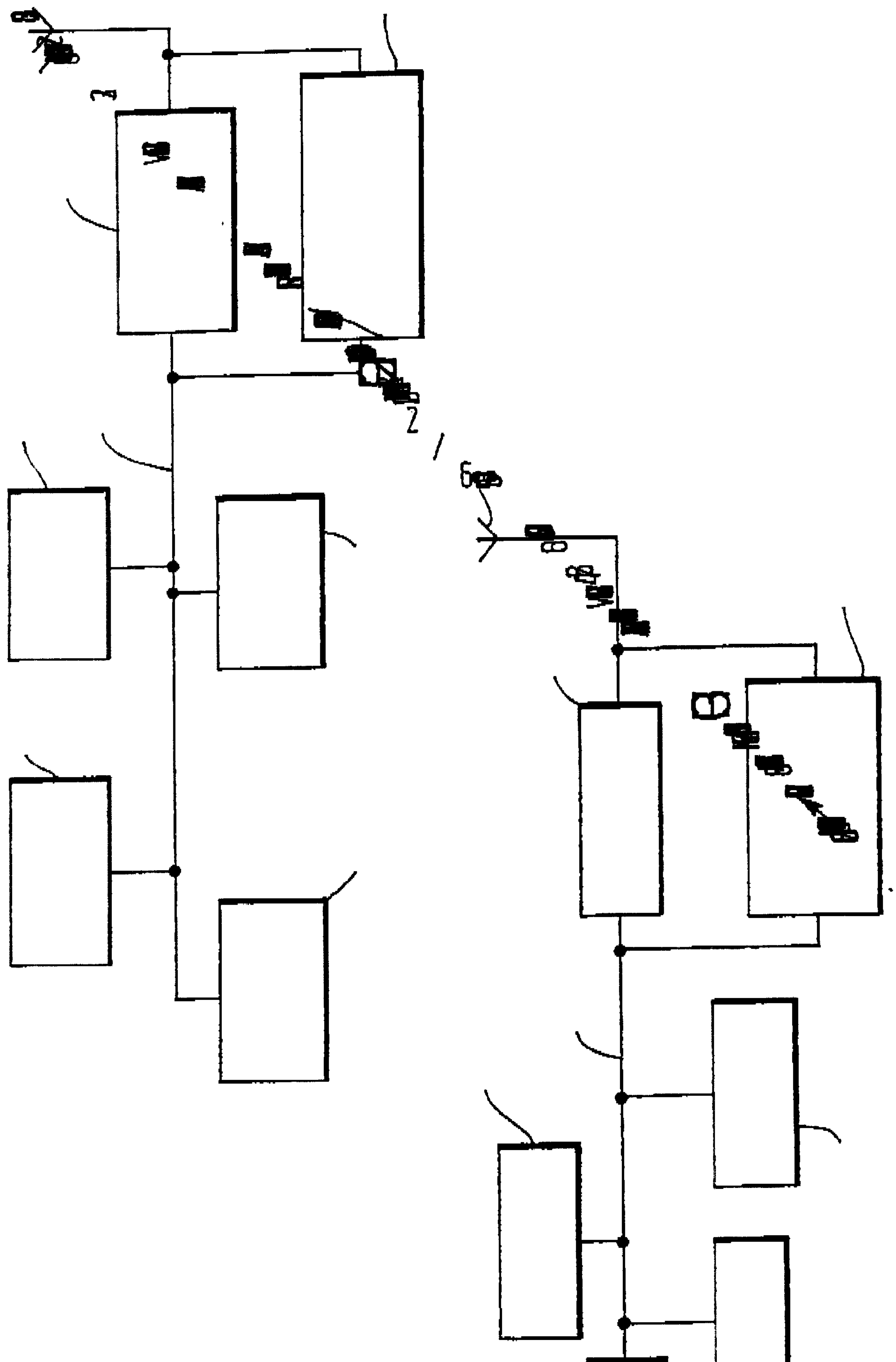




6

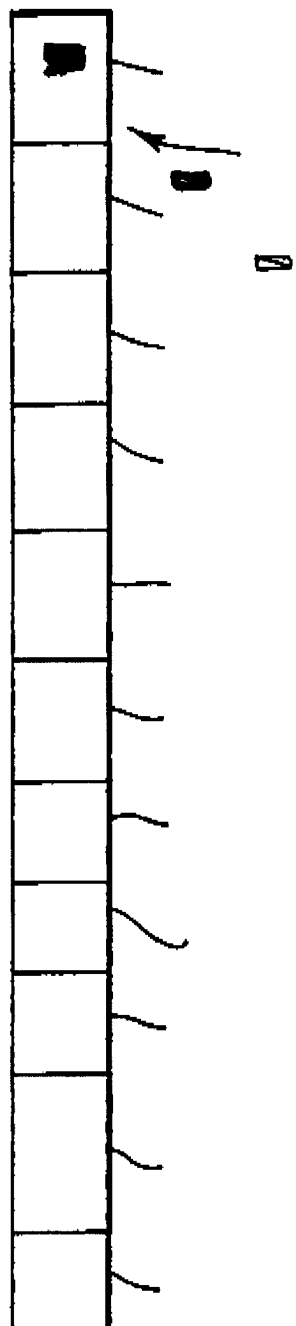


FIG. 5A

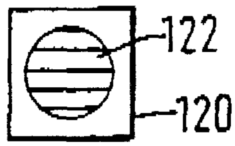


FIG. 5B

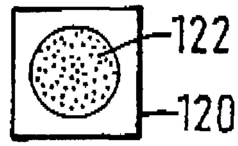


FIG. 5C

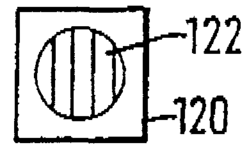


FIG. 6A

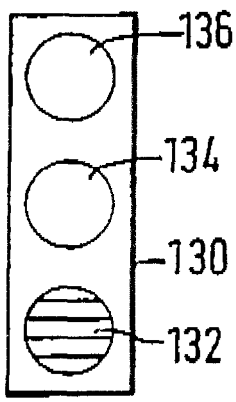


FIG. 6B

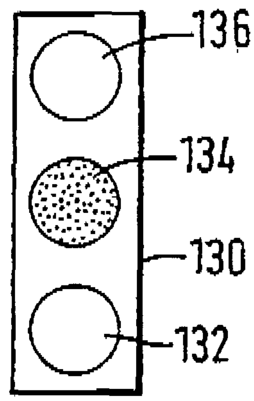


FIG. 6C

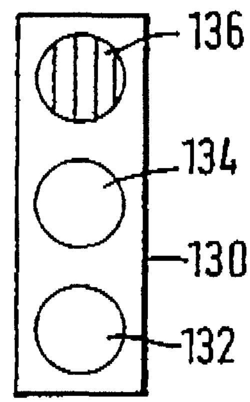


FIG. 7A

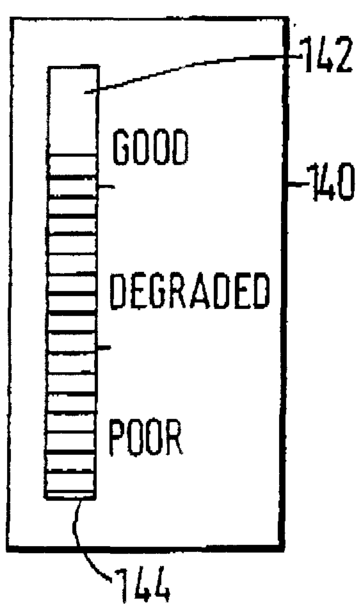


FIG. 7B

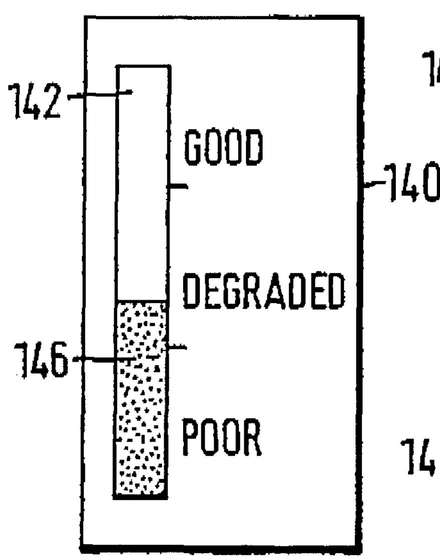
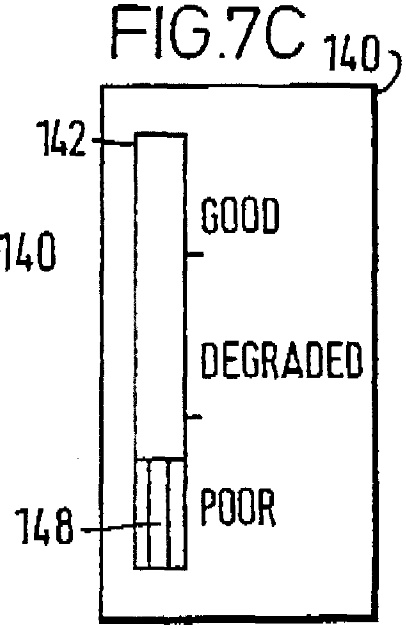
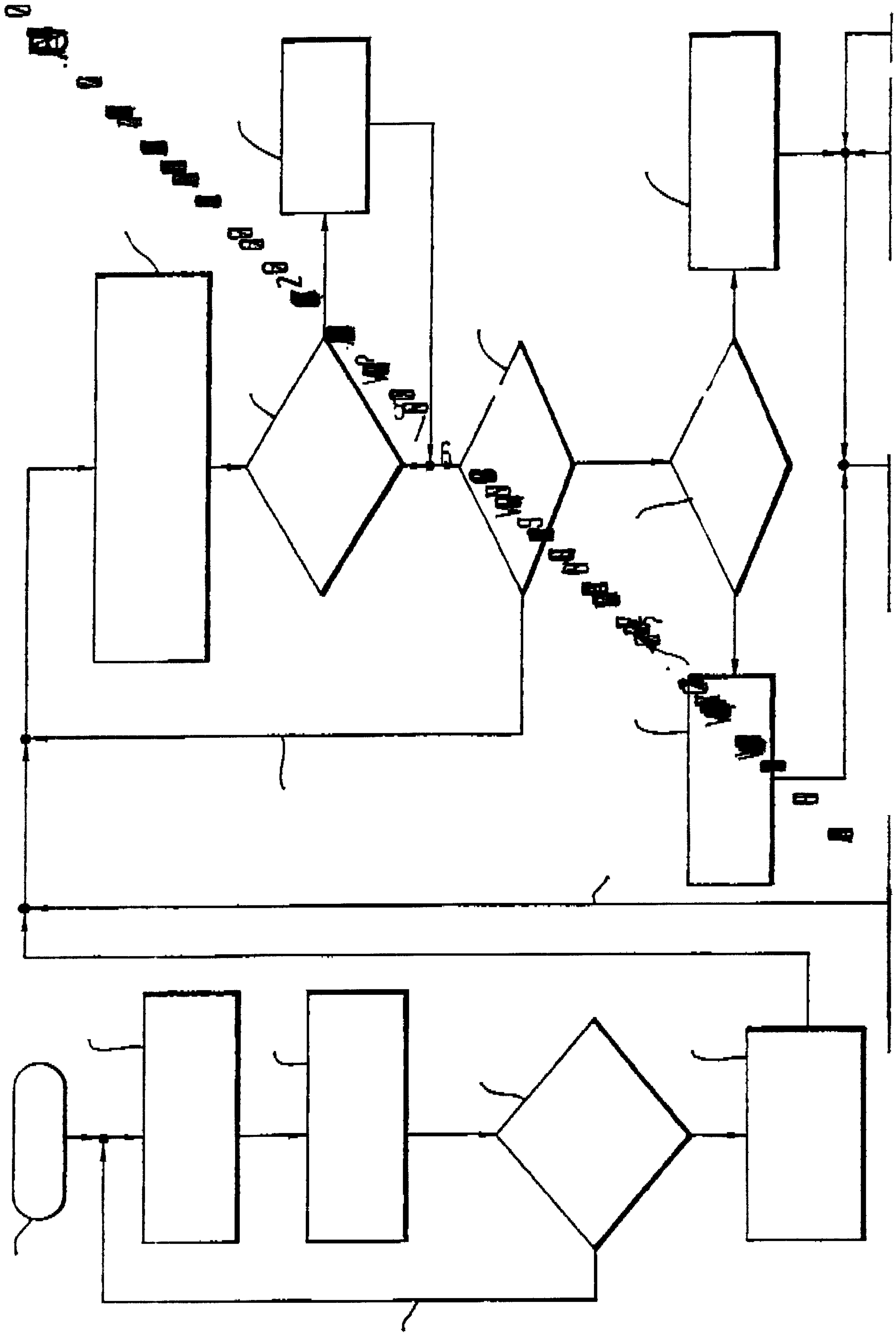
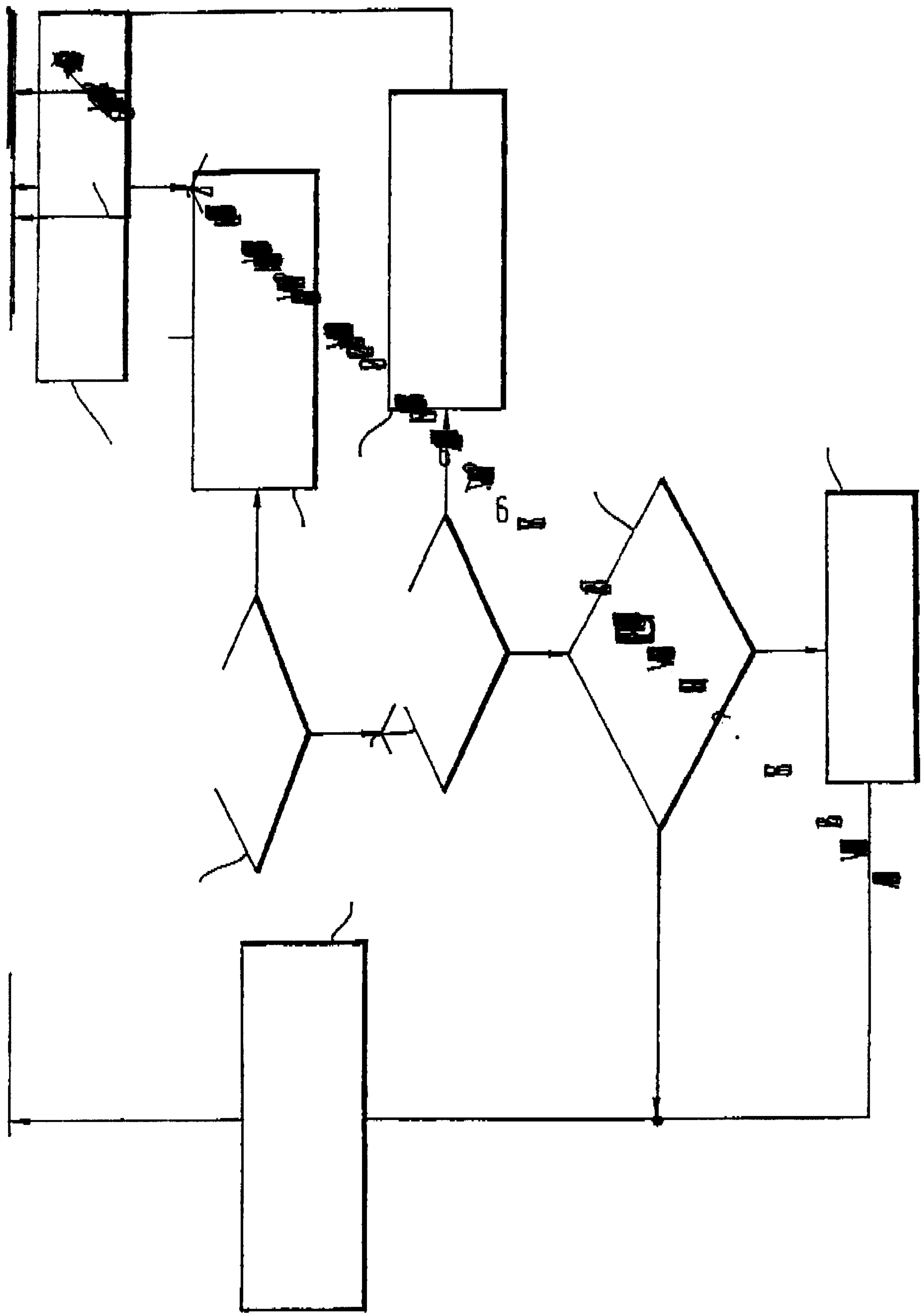


FIG. 7C







MOBILE WIRELESS STATION HAVING COMMUNICATIONS QUALITY INDICATOR

This invention relates to wireless communications systems.

With a view to obviating the need for wired cabling connections between stations in local area networks (LANs), wireless local area networks have been developed and are now commercially available. However, the coverage area of wireless LANs is restricted especially in an indoor environment, due to the presence of structural features such as walls and floors in buildings, for example. Also, it may be desirable for stations in a wireless LAN to communicate with remote facilities or resources such as servers. Therefore, it has been proposed to connect base stations to a backbone LAN such as a wired LAN, which can be connected to the remote facilities. The base stations define respective wireless communication cells. Where a mobile wireless station, such as a portable data processing unit provided with a wireless transceiver, for example, moves around it may move in and out of the range of various base stations connected to the backbone LAN. It is therefore necessary for the mobile station to hand over communication from one base station to another as it moves around. With this arrangement, there will be fluctuations in the communications quality experienced by the mobile station and even places where the communications quality is so poor that no satisfactory communication can take place (dead spots).

A user operating a mobile station in such a system may not directly experience the performance degradation or loss of communication if the station is carrying out communication tasks autonomously, that is, without directly associated interaction with the user. Thus, certain "background" tasks that involve data communication to servers may be performed as the station moves around, while the user is running a "foreground" task that is not directly communication orientated. This has the disadvantage that when the user next needs data communication he will be unaware that the communications quality has degraded or communication has been lost and may attempt to carry out a task which cannot be performed.

It is an object of the present invention to provide a wireless communications system including a mobile wireless station, wherein the aforementioned disadvantage is alleviated.

Therefore, according to the present invention, there is provided a wireless communications system, including a plurality of intercommunicating access points and a mobile wireless station, characterized in that said mobile wireless station is adapted to communicate with a selected access point and includes communications quality determining means adapted to determine a communications quality value for messages transmitted by said selected access point, and visual indicator means responsive to said communications quality value to provide a visual indication dependent on said communications quality value.

It will be appreciated that in a system according to the invention the provision in a mobile wireless station of a visual indication of communications quality serves to advise the user of the mobile wireless station of such communications quality and hence of the state of communications with an access point.

Embodiments of the present invention will now be described by way of example, with reference to the accompanying drawings, in which:-

Fig. 1 is a diagram of a wireless communications system having a plurality of access points connected in a local area network, and a plurality of mobile wireless stations;

Fig. 2 is a block diagram of a mobile wireless station;

Fig. 3 is a block diagram of an access point;

Fig. 4 is a diagram of a beacon message transmitted by the access points;

Fig. 5A to 5C illustrate a first type of visual indicator which may be employed in the mobile wireless station;

Figs. 6A to 6C illustrate a second type of visual indicator which may be employed in the mobile wireless station;

Figs. 7A to 7C illustrate a third type of visual indicator which may be employed in the mobile wireless station; and

Figs. 8A and 8B show a flowchart illustrating the operation of the visual indicators in the mobile wireless station.

Referring first to Fig. 1, there is shown a wireless communications system 10 including a backbone LAN (local area

network) 12 which is a wired, cable-based LAN, and which includes a cable 14 connecting to a plurality of base stations referred to herein as access points 16, referenced individually as access points 16-1, 16-2 and 16-3. The access points 16 have antennas 18 referenced individually as antennas 18-1, 18-2 and 18-3. A server 19 is connected to the cable 14 to provide a server function for devices communicating with the LAN 12. Also included in the system 10 are a plurality of mobile stations 20, referenced individually as mobile stations 20-1, 20-2 and 20-3. The mobile stations 20 have antennas 22, referenced individually as antennas 22-1, 22-2 and 22-3. The access points 16 have overlapping coverage areas, referred to as cells 24, referenced individually as cells 24-1, 24-2 and 24-3. Within the wireless coverage area formed by the combined cells 24-1, 24-2 and 24-3, the mobile stations 20 can move around freely while staying in permanent logical connection with the backbone LAN 12 and server 19.

Referring now to Fig. 2, there is shown a block diagram of a mobile wireless station 20. The mobile wireless station 20 includes a wireless transceiver 30 coupled to the antenna 22 and to a bus 32. The mobile station 20 also includes, connected to the bus 32, a processor 34, a memory 36, an optional keyboard 38 and a colour display screen 40. Other devices such as a printer may be connected to the bus 32. The mobile wireless station 20 is effectively a small portable data processing terminal. A signal level and noise level measurement circuit 42 is connected to the antenna 22 and the bus 32 and is adapted to measure the signal level of beacon messages and the noise level in the neighbourhood of the antenna 22. A communications quality (CQ) value is computed utilizing the measured signal and noise levels in a manner which will be explained in more detail hereinbelow.

Referring now to Fig. 3 there is shown a block diagram of an access point 16. The access point 16 includes a wireless transceiver 50 coupled to the antenna 18 and to a bus 52. A further transceiver 54, connected to the bus 52, connects the access point 16 to the cable 14 of the backbone LAN 12 (Fig. 1). Also connected to the bus 52 are a processor 56, a memory 58 and a filtering database 60 which stores data identifying the location of devices in the system 10, in relation to the access point 16. A noise level measurement circuit 62 is connected to the antenna 18 and the bus 52 and is adapted to measure the noise level experienced by the access point 16.

The access points 16 transmit beacon messages at regular intervals, for example at intervals of one second. Referring to Fig. 4, there is shown the format of such a beacon message 70. The beacon message 70 includes a first preamble portion (PR-1) 72, a network ID (NWID) portion 74, a second preamble portion (PR-2) 76, a start delimiter portion 78, a destination address (DA) portion 80, which is a broadcast address ensuring reception by any mobile station in the cell 24 covered by the access point 16 such as the mobile station 20, a source address (SA) portion 82, which is the access point address for the access points cell 24, a length portion 84, a message identification (MID) portion 86, which identifies the message 70 as a beacon message, a wired address (WA) portion 88, which is the access point address for the wired LAN 12, a noise level (NL) portion 90, which represents the noise (background interference) level as measured by the noise level measurement circuit 62 (Fig. 3) a sequence number portion 92, three threshold value portions 94, 96 and 98 (to be explained hereinafter), a pad portion 100 and a frame check sequence (FCS) portion 102.

It will be appreciated that as a mobile station 20 moves around, the communications quality (CQ) of the messages received by the mobile station will vary. In this connection, it should be understood that a mobile station is "signed-on", that is, communicates with, only a single access point 16 at any one time. If the communications quality becomes sufficiently poor, and an access point having a better communications quality can be identified, then a handover to the new access point is effected, as will be described in more detail below.

Referring again to Fig. 1, it is seen that mobile station 20-1 is initially at point A in cell 24-1 and so signed on to access point 16-1. If the station 20-1 moves from point A to point B, as shown by the arrow 110, it will move to cell 24-3, and so be handed over to access point 16-3 at some point in time. Mobile station 20-2 is initially at point C in cell 24-2 and so signed on to access point 16-2. If the mobile station 20-2 moves to point D, as shown by the arrow 112, it will stay in cell 24-2, and no handover will take place. Mobile station 20-3 is initially at point E in cell 24-3, and so signed on to access point 16-3. If the mobile station 20-3 moves to point F, as shown by the arrow 114, it will move out of range of all access points and enter a so-called dead spot where the communications quality with any one of the access points 16

on the backbone LAN 12 is so poor that no effective communication is possible.

In the preferred embodiment, the communications quality (CQ) value is calculated by first determining the maximum of the noise level value measured at the mobile station 20 by the measurement circuit 42 (Fig. 2) and the noise level value at the access point 16 as measured by the noise level measurement circuit 62 (Fig. 3) and transmitted in the beacon message 70 (Fig. 4) as portion 90 thereof. The signal level value of the beacon message 70 as measured by the measurement circuit 42 (Fig. 2) is then divided by the determined maximum noise level value. The resulting value is then applied as an input to a running averaging process, wherein the previous value accounts for 80% and the new value for 20%. The output of this averaging process is the communications quality (CQ) value. Operating in this manner ensures that temporary fluctuations in noise level will not immediately result in cell searches. The CQ value will exhibit only gradual increases or decreases. If the mobile station 20 detects that a beacon message is missing between two beacon messages that are received, which is effected using the sequence number portion 92(Fig. 4) in the beacon messages 70, it includes such a missing beacon message in the averaging calculation as a predetermined very low value. If the mobile station 20 detects that no further beacon messages are received, it assumes that it has moved out of reach of all access points 16 and sets the CQ value to a predetermined low value, which is below a fixed threshold value referred to as the fast cell search threshold value FTH to be explained hereinbelow.

With the above exemplary situations in mind, it will be appreciated that a user of a mobile station 20 may move around such that the communications quality of messages transmitted between the mobile station 20 and the backbone LAN 12 varies. Thus when the mobile station 20 is well within the cell of an access point 16 the communications quality may be good. However, as the mobile station moves out of range of that access point, the communications quality may become degraded, and a search for a new access point initiated (see arrow 110 in Fig. 1). Moreover, the mobile station may move out of the range of all access points, and be in a dead spot, such as point F in Fig. 1.

The user of the mobile station may be executing a foreground task which does not involve communication with the backbone LAN 12, while the mobile station is performing autonomous background tasks which involve communication with the server 19 via the backbone LAN 12. Such communication may become degraded in quality or, in a dead spot situation, become impossible. With a view to alerting the user of the communications quality experienced at the mobile station 20, a visual indication is provided. Such visual indication may be in the form of a continuous display, or may be operated only when the communications quality becomes sufficiently poor, as in a dead spot. In the preferred embodiment, the visual indication is in the form of a window in the display screen 40 (Fig. 2). However in an alternative arrangement a separate visual indicator could be provided in the mobile station 20.

Three types of visual indicator will now be described. Referring first to Figs. 5A to 5C there is shown a window 120 which is in the colour display screen 40 (Fig. 2) and which contains a circular region 122. The colour of the circular region 122 is indicative of the communications quality. Thus, the horizontal hatching in Fig. 5A represents a green colour corresponding to good communications quality, the stippling in Fig. 5B represents a yellow colour corresponding to degraded communications quality, and the vertical hatching in Fig. 5C represents a red colour corresponding to poor communications quality as in a dead spot.

Referring to Figs 6A to 6C there is shown an alternative type of display in the form of a window 130 in the colour display screen 40 (Fig. 2), which contains three circular regions 132, 134 and 136 aligned in a vertical direction on the screen in the manner of a traffic light. Thus the lowest circular region 132 can display a green colour (Fig. 6A) corresponding to good communications quality. The central circular region 134 can display a yellow colour (Fig. 6B) corresponding to a degraded communications quality and the top circular region 136 can display a red colour (Fig. 6C) corresponding to poor quality communication as in a dead spot.

Referring to Figs. 7A to 7C, there is shown another alternative type of display in the form of a window 140 in the display screen 40 (Fig. 2) which contains a vertical bar indicator 142 which can operate analogously to a thermometer. Thus the vertical bar 142 contains a

green colour portion 144 (Fig. 7A) for good communications quality, a smaller yellow portion 146 (Fig. 7B), for degraded communications quality, and a still smaller red portion 148 (Fig. 7C) for poor quality communications quality, as in a dead spot.

In a modified form of the vertical bar indicator (Figs. 7A to 7C), only a single colour is employed, the height of the coloured portion alone being sufficient to indicate the communications quality level. In another modification, suitable for use where the mobile station 20 has a monochrome (black and white) display screen instead of a colour display screen, a grey shades scheme could be used for the communications quality indication, for example a dark shade could indicate good communications quality, a medium shade could indicate degraded communications quality, and a light shade could indicate poor communications quality, as in a dead spot. In yet another modification, an audible signal can be generated whenever the visual indicator indicates a dead spot.

The operation of the mobile station 20 will now be explained in more detail with reference to the flowchart 200 shown in Figs 8A and 8B. From the start state (block 202), the flowchart proceeds to a state where the mobile station 20 listens to beacon messages from all access points it can detect (block 204) and selects the access point providing the beacon message having the best communications quality (block 206). A comparison test with a threshold value is then made (block 208) to ascertain whether this best CQ value is at least an acceptable level. If not, the flowchart returns to block 204 via line 210. If the CQ value is of an acceptable level, then the mobile station signs on to the access point 16 providing the best CQ value, that is, the mobile station 20 will process messages only from that access point, in accordance with the NWID portion of the messages.

The mobile station 20 then proceeds to ascertain the communications quality value of each beacon message received from the access point 16 to which it is signed on (block 214). A query is then made (block 216) as to whether the mobile station is programmed to provide a continuous display and if so such display is updated (block 218), that is, a visual indication in accordance with Figs. 5A-5C, 6A-6C or 7A-7C, is updated to reflect the communications quality of the current beacon message. If there is not a continuous CQ display then the flowchart proceeds to block 220 where a test is made as to whether the

communications quality value is below a predetermined threshold value RTH, referred to as the regular cell search value.

If the CQ value is not below the RTH value, the flowchart returns to block 214 as shown by line 222. If the CQ value is below the regular cell search threshold value RTH, then a further test is made (block 224) to ascertain whether the CQ is below a further predetermined threshold value FTH, which is lower than RTH, and is referred to as the fast cell search threshold value. If the answer to this query is no, then a degraded quality indication (Fig. 5B, 6B or 7B) is caused to appear on the display screen 40. This indication advises the user of the mobile station 20 that the communications quality has degraded and that a search is being made for a new access point 16 for communicating with the mobile station 20. If the CQ value is below the threshold value FTH then a dead spot warning (Fig. 5C, 6C or 7C) is caused to appear on the display screen 40.

After displaying the appropriate warning (block 226 or block 228), the flowchart proceeds to block 230 and the CQ values of all access points which can be detected are ascertained. If the best such CQ value is below the fast cell search threshold value FTH then the dead spot warning is displayed or repeated (block 234) and the flowchart returns to block 230 via line 236. If the best CQ value is above FTH then a determination is made as to whether the best CQ value is above a further threshold value STH, referred to as the stop cell search threshold value. The value STH is greater than the value RTH so as to avoid repeated change between access points during a handover procedure for a mobile station. If the best CQ value is not above STH, then the cell search warning is displayed or repeated (block 240) and the flowchart return to block 230 via line 242.

If the best CQ value is above the stop cell search threshold value STH and a change to a new access point is required (block 244), a handover to the new access point is effected (block 246), the dead spot or cell search warning indicator is removed (block 248), and the flowchart returns to block 214 via line 250. If no change to a new access point is required (block 244), the current access point is maintained and the cell search or dead spot indicator is removed (block 248) without any access point handover and the flowchart returns to block 214 via line 250.

CLAIMS:-

1. A wireless communications system, including a plurality of intercommunicating access points (16) and a mobile wireless station (20), characterized in that said mobile wireless station (20) is adapted to communicate with a selected access point (16) and includes communications quality determining means (34,42) adapted to determine a communications quality value for messages transmitted by said selected access point (16), and visual indicator means (120,130,140) responsive to said communications quality value to provide a visual indication dependent on said communications quality value.

2. A wireless communications system according to claim 1, characterized in that each said access point (16) is adapted to transmit beacon messages (70) at regular intervals, and in that said communications quality value is determined using said beacon messages (70).

3. A wireless communications system according to claim 2, characterized in that each said beacon message (70) includes an identification portion (82) identifying the access point (16) which transmits that beacon message (70).

4. A wireless communications system according to any one of the preceding claims, characterized in that said communications quality determining means includes: measuring means (42) adapted to measure the signal level of received beacon signals and the noise level at said mobile wireless station; and processing means (34), coupled to said measuring means (42) and adapted to determine said communications quality value in dependence on the ratio of the measured signal level and the measured noise level.

5. A wireless communications system according to claim 4, characterized in that each said beacon message (70) incudes a noise level portion (90) representing the background noise level at the access point (16) transmitting that beacon message (70), and in that said processing means (34) is adapted to include said noise level portion (90) when determining said communications quality value.

6. A wireless communications system according to any one of the preceding claims, characterized in that said visual indicator means (120,130,140) is continuously operative.

7. A wireless communications system according to any one of claims 1 to 5, characterized in that said visual indicator means

(120,130,140) is operative when said communications quality value falls below a predetermined value (RTH, FTH).

8. A wireless communications system according to any one of the preceding claims, characterized in that said visual indicator means (120,130,140) is adapted to display a first colour indication when said communications quality value falls below a first threshold value (RTH) and a second colour indication when said communications quality value falls below a second threshold value (FTH), less than said first threshold value (RTH).

9. A wireless communications system according to claim 8, characterized in that said first threshold value (RTH) represents a value at which a search for a new access point (16) is initiated and said second threshold value (FTH) represents a value at which communication between said mobile station (20) and the access point (16) transmitting the received beacon message is not possible.

10. A wireless communications system according to any one of the preceding claims, characterized in that said plurality of intercommunicating access points (16) are connected in a local area network (12).

Examiner's report to the Comptroller under Section 17 (The Search report) -11-

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Relevant Technical Fields (i) UK Cl (Ed.M) H4L (LFM, LDSD) H3Q (QBLX) H4K (KY4M, KY4D14Q) H4P (PEUL, PEUX, PPD) (ii) Int Cl (Ed.5) H03J 3/14, H04B 17/00, H04L 12/28 H04Q 7/04	Search Examiner MR JOHN CAGE Date of completion of Search 10 MAY 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI	Documents considered relevant following a search in respect of Claims :- 1,2,4,6,7

Categories of documents

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Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2257332 A	(VIDEO TECHNOLOGY) see page 19 line 9 - page 20 line 25, page 72 lines 16-20	1,2,7
Y	GB 2204215 A	(MITSUBISHI) see page 6 lines 9-15	4
X,Y	GB 2178270 A	(OKI ELECTRIC) see Figure 1 and page 3 lines 99-114	X:1,7 Y:4
X,Y	EP 0310379 A2	(TOSHIBA) see Figure 4 and column 1 lines 24-45	X:1,7 Y:4
X	EP 0236946 A2	(NEC) see Figure 1	1,6
X	WPI Abstract Accession No 90-308349/31 and JP 2-217049		1,6

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